# Neonatal Care Units

## Introduction

The initial source of microbial colonization and of infection in the newborn is the mother. The maternal flora provides the normal flora of the healthy infant. Subsequently, in the nursery the infants themselves can serve as both major reservoirs of potential pathogens or, given their immature immune systems, be at increased risk of exposure and infection from exogenous pathogens from care givers or from the nursery environment. Infection control strategies should be based on the principle that each infant is a potential source and a potential recipient of microorganisms. [19] Neonates are uniquely susceptible to health-care associated (HAI) infections and the majority of blood stream infections occurring in the Neonatal Intensive Care Unit (NICU) can be considered to be health care associated.

HAIs are a significant problem in Egyptian NICUs. In 2001 very high rates of sepsis (as high as 70%) were documented in a number of NICUs in Egypt. An investigation revealed a direct relationship between sepsis and extrinsic contamination of IV fluids. Intervention directed at improving infection control measures related to preparation and maintenance of IV fluids resulted in decreases in the rate of intravascular (IV) catheter related bloodstream infection (CRBSI) and a subsequent reduction in mortality in selected NICUs.

Two key factors that effect frequency of HAIs in neonatal care units include the proportion of very low birth weight neonates and extent of utilization of invasive devices. One recent investigation found that over half of the HAIs identified among patients in the NICUs surveyed were CRBSIs followed by lower respiratory tract (12.9 %), ear-nose-throat (8.6%) and urinary tract infections (8.6%). [20]

## Transmission of Infection in Neonatal Care Units:

The combination of intensive care and high frequency of exposure of neonates to antibiotics (50-95%) provides an opportunity for emergence of antimicrobial resistant microorganisms. Common pathogens among this population therefore

are coagulase-negative staphylococci (CoNS). The typical mode of transmission for these to neonates is from the hands of HCP. Other routes of transmission such as droplet and airborne transmission are relatively rare. Other exogenous sources of microorganisms include contamination of IV solutions and medications, respiratory care equipment, and reservoirs of waterborne microbes.

# Infection Prevention in Neonatal Care Units

**General principles:**

- Handling of neonates should be minimized.
- Measures should be taken to minimize the risk of transmission of pathogens from mother to infant.
- Staff should perform handwashing between infants as well as upon entering and leaving the nursery or NICU.
- Equipment and supplies should not be shared between infants.[19]

Additionally, since infants do not have fully mature defense systems, invasive procedures are more likely to result in the colonization of microorganisms than when the same procedures are performed on adults.[19]

This means that:

- Procedures that further diminish host defenses should be used cautiously and with appropriate aseptic technique.
- Use of therapies that decrease the need for invasive procedures or that enhance host defenses should be considered.[19]

# Neonatal Care Practices

## IV cannulae insertion

Before cannula insertion, use aseptic techniques by doing the following:

- Wash hands aseptically
- Wear sterile gloves
- Disinfect the skin
- Use no-touch technique

## IV Therapy

Each NICU should designate persons to be trained in the preparation of IV fluids, peripheral IV line placement, preparation of IV medications and administration of IV medications and additional fluids. They should establish a dedicated area for preparation of medications and IV fluids. This area should

not be used to store/place any biologic material (e.g. tubes of blood, formula and others). Preparation of IV fluids, preparation of IV medications/drugs, and administration of medications/drugs are important activities that have to be performed safely to prevent infections inside NICUs. Therefore, task analysis was performed where all steps required are described in details to avoid any contamination. Three main critical activities will be described:

A. Preparation of IV fluids
B. Preparation of IV medications/drugs
C. Administration of IV medications/drugs

## A. Critical Steps in Preparation of IV fluids:

1. Perform routine/hygienic hand wash
2. Prepare and clean working area with a disinfectant
3. Gather necessary materials (IV fluids, drugs, syringes, needles, disinfecting materials, etc.) and place them in the clean area, if possible on a clean cloth/towel.
4. Inspect IV fluid containers for expiry date, cracks, leaks, cloudy/turbid, etc.
5. Wash hands with an antiseptic for 2-3 minutes. Dry hands with paper towel or fresh cloth towel or perform alcohol hand rub.
6. Disinfect the port of IV bottles/bags with appropriate disinfectant (70% alcohol) immediately before removing/adding fluids.
7. Wear sterile gloves
8. Use a sterile needle/syringe for each iv fluid bottle and ampoule/vial by using the no-touch technique during mixing the iv fluids and medications. (Never enter iv bottles/bags with a needle except through designated ports)
9. Dispose syringe and needle accordingly after use.
10. Use sterile base container in mixing the iv fluids (the container that has the largest volume of the mixture wanted i.e. adding the smaller amount of fluids to the larger amount which will be the base)
11. Label bottle with patient's name, date and time of preparation.
12. Carry the bottles on clean tray to the nurse in charge of the unit or store in fridge (all prepared fluids which are not used have to be disposed after max. 24 hours).

## B. Critical Steps in Preparation of IV medications/drugs:

1. Use single-dose ampoules rather than multidose vials. If multi-dose vials must be used, always pierce the septum with a sterile needle.

Never enter multi-dose vials with a needle or syringe that has been used on a patient. Use a new needle every time you stick into the multi-dose vial.

2. If a multi-dose vial needs to be resolved, the used needle/syringe must be disposed. For each draw from the vial a new sterile needle and syringe must be used.
3. Before filling a syringe from an ampoule or multi-dose vial, inspect for any contamination, turbidity, cracks, leaks, and expiry date.
4. Between each draw the top of the vial should be wiped once with alcohol and a cotton pad.
5. Use for each vial/ampoule a new sterile needle and syringe.
6. Any medication left in the vial should be kept in a fridge for no more than 24 hours or less if the manufacturing instructions doesn't allow a 24 hours storage
7. Aseptic hand washing or alcohol rub should be performed before each use of a multi-dose vial/ampoule.

### C. Critical Steps in Administration of IV medications/drugs:

A. Every step must follow strict aseptic techniques

B. Maintain a closed system at all times.

C. Do not mix medications together.

D. If medications are not compatible with IV fluid, the IV line needs to be stopped and flushed before administration as follows:

   a. Stop the IV fluid first

   b. Flush the canula with saline solution

   c. Infuse the medication

   d. Flush again

   e. If needed infuse the second medication and flush again.

   f. Restart the routine IV fluid.

## IV Therapy - Umbilical Catheters

**I. Insertion of umbilical catheter:** Umbilical catheters should be inserted using sterile techniques.

**II. Replacement of catheters**

A. Only replace umbilical venous catheters if the catheter malfunctions.

B. Remove and do not replace umbilical artery catheters if any signs of local infection, CRBSI, vascular insufficiency, or thrombosis are present.

C. Remove and do not replace umbilical venous catheters if any signs of local infection, CRBSI or thrombosis are present.

**III. Catheter-site care**

A. Cleanse the umbilical insertion site with an antiseptic before catheter insertion. Avoid tincture of iodine because of the potential effect on the neonatal thyroid. Other iodine-containing products (e.g., povidone-iodine) can be used.

B. Do not use topical antibiotic ointment or creams on umbilical catheter insertion sites because of the potential to promote fungal infections and antimicrobial resistance.

C. Add low doses of heparin (0.25–1.0 F/ml) to the fluid infused through umbilical arterial catheters.

D. Remove umbilical catheters as soon as possible when no longer needed or when any sign of vascular insufficiency to the lower extremities is observed. Optimally, umbilical artery catheters should not be left in place >5 days.

E. Umbilical venous catheters should be removed as soon as possible when no longer needed but can be used up to 14 days if managed aseptically.

## Cord Care

The cord should be cut and tied using aseptic technique.

## Skin Care

- Once the newborn's temperature has stabilized, maternal blood and secretions should be removed with sterile cotton sponges and warm water. Because of the risk of infection with blood-borne pathogens, personnel handling the neonate should wear gloves until completed.
- After removal of secretions, localized cleaning of the diaper area and other soiled areas should be carried out as needed using warm water with or without mild soap.

- Minimize procedures that damage the skin, such as excessive manipulation or drying, or those that cause trauma such as adhesive tape.
- Whole body bathing and antiseptic soaps are not necessary for routine care, but may be indicated in outbreaks.
- Chlorhexidine has been used in outbreak control as it is not toxic and absorption is minimal.

## Eye Care

- At delivery the newborn's eyes should be cleaned with sterile cotton to remove secretions and debris.
- Newborns should receive topical antimicrobial prophylaxis against *Neisseria gonorrhoeae.*
- Nosocomial conjunctivitis occurs frequently in NICUs. Eyes may become infected with water-borne organisms in humid incubators or from contamination with respiratory tract secretions. Care should be taken to prevent contamination of the eyes with drips from suction catheters after suctioning the nasopharynx or endotracheal tube.

## Infant Feeding

### Maternal breast milk

- Expression of breast milk may be necessary when a sick infant is unable to suck.
- Breast milk should be collected and stored aseptically.
- Hands should be washed with an antiseptic and the milk should be expressed into sterile containers.
- If a breast pump is used, all pump components in contact with milk should be washed with hot soapy water after each use and sterilized or disinfected daily.
- Milk must be stored in a refrigerator for no more than 48 hours or frozen at -20° C for up to 6 months:
    - Frozen milk should be thawed quickly under running water with precautions to prevent contamination.
    - Milk should not be subjected to excessive heat from hot water or a microwave oven.
    - After thawing, milk should be used promptly or stored in a refrigerator for no longer than 24 hours.

- Breast milk should not be used if the mother has an infection that can be transmitted through it.
- Taking routine cultures of expressed milk is not recommended.
- Culturing may be indicated if there is concern about collection technique or if neonatal infection is suspected.

**Formula**

- Sterile formula, prepared ready to feed, should be used within 4 hours of uncapping.
- Aseptic techniques should be used to prepare formula from liquid concentrates or powders. Utensils and containers should be sterilized, decontaminated, or boiled for 5 minutes before use. Water should be sterile or boiled. Blenders should be cleaned after each use and sterilized daily.
- Formula should be bottled in volumes for individual feeds or for 4 hours of continuous feeding.
- Formula can be refrigerated for a maximum of 24 hours and used within 4 hours of opening.

**Routine culturing of formula is not recommended** but cultures may be indicated if the formula is implicated in infection.

# Aseptic Techniques

## Hand Hygiene for Neonatal Care Unit Personnel

While there is a spectrum of hand hygiene from the routine hand wash to the surgical hand antisepsis, the actual procedure to be used should be based on the patient care activity (e.g. a routine hand wash for contact with environmental surface to hand antisepsis using antiseptic soap or alcohol handrub prior to inserting an IV.)

**Notes**:

- Each facility should establish and enforce hand hygiene procedures for nurseries. All persons entering the nursery should be informed of the policy.
- **Aseptic hand wash or alcohol based hand rub should be performed:**
    - Before entering the NICU
    - Before any invasive procedure (e.g. cannula insertion and removal)
    - Before mixing of IV fluid
    - Before use of multidose vials.
    - Before adminstration of iv fluids or medications/drugs

- **Routine hand wash should be performed:**
    - Before and after any contact with the neonate e.g. bathing, changing diapers, feeding or performing physical examination.
    - After touching environmental surfaces
    - Before and preparation of milk formulae.
    - Whenever soiled.

# Barrier precautions

## Gloves

Single-use gloves are recommended during all patient contacts (especially with septic neonates) and changed between patients.

**Indications for wearing gloves are:**

- Gloves for added protection when there is a heavy microbial load, such as with infectious diarrhea, draining skin lesions, purulent conjunctivitis, or infection with rotavirus, hepatitis A, or enterovirus.
- Gloves are also recommended for care of infants with respiratory viral infections in order to reduce the risk of accidental self-inoculation.[19]
- Wear sterile gloves before performing invasive procedures and IV fluid preparation.
- Single use gloves are recommended before any patient's contact.
- Change gloves between patients or if gloves are visibly soiled or contaminated when handling the same patient.

## Gowns

- A gown protects the infant from contact with the wearer's clothing and prevents contamination of the healthcare worker's exposed skin with the infant's flora. In practice, personnel rarely handle newborns outside of their incubators. Most direct contact occurs via the hands.
- A gown should be worn if a newborn is to be handled outside the incubator where direct contact is expected and invasive procedures are done.
- A single gown should be used for one baby.

Gowns are recommended for contacts with infants with certain infections. However, provision of scrub suits or other special attire for personnel who spend most of the day in the NICU may have benefits unrelated to infection control.

## Invasive Procedures

- Any procedure that interrupts the normal barriers to infection will present a higher infection risk in the newborn period than later in life.
- Newborns are subjected to certain invasive procedures that can result in localized and/or systemic infections.
- Nasogastric tubes provide portals of entry and sites of potential overgrowth of microorganisms in the upper gastrointestinal tract.
- Nutrition administered by continuous infusion remains at room temperature for several hours allowing microorganisms to proliferate during infusion.
- Bacterial colonization and infection of intravascular catheters occurs more frequently in newborns than in older children.[19]

## Other Neonatal Procedures

- Whenever a new procedure or device is introduced into the nursery, the potential for nosocomial infection should be assessed. If indicated, protocols should be established to minimize infection risk and surveillance should be instituted to monitor for infection.
- The need for any invasive device should be reassessed daily. Device use should be discontinued promptly if it is no longer essential.
- In general, infection control guidelines for the insertion and maintenance of intravascular catheters, endotracheal tubes, urinary catheters, dialysis catheters, and ventricular drains in the newborn are not different from those in older patients.
- Umbilical vessel catheters are frequently used in the initial short-term management of the sick newborn. The nonsterile insertion site and devitalized cord tissue increase potential for bacterial colonization of these lines. They should be replaced by percutaneous peripheral or central venous catheters in infants requiring long-term vascular access.
- Continuous infusion tube feeding should be set up with the same aseptic precautions used for intravenous fluids.

# Surveillance

A. Surveillance should be conducted in ICUs and other patient populations to determine CRBSI rates, monitor trends in those rates, and assist in identifying lapses in infection control practices.

B. ICU data is expressed as the number of cannula -associated BSIs per 1,000 catheter-days and are stratified by birth weight categories for neonatal ICUs to facilitate comparisons with data from other health care facilities in comparable patient populations and health-care settings.

Events leading to unexpected life-threatening or fatal outcomes should be investigated. This includes any process variation for which a recurrence would likely present an adverse outcome.

**To reduce the risk from blood transfusions:**

- Blood products should be used with caution and with consideration of all of the risks and benefits.
- Cellular blood products given to newborns less than 1250 g who are cytomegalovirus (CMV-seronegative) or of unknown CMV status should be from CMV-seronegative donors or depleted of CMV by freezing or filtration.
- Similar precautions should be considered for larger seronegative newborns receiving large volumes of blood.[19]

# Isolation in NICU

## Use of Isolation Rooms

Most infections in newborns do not require special isolation precautions. Most newborn care measures, if followed, will prevent transmission of most infections between newborns. Additionally, newborns are nonmobile so there is no direct contact between patients. Furthermore, the number of nursery isolation rooms available is generally limited, may be inadequate for the care of critically ill patients, and requires one-on-one staffing. [19]

**Isolation rooms are seldom indicated if:**

- There are adequate numbers of nursing and medical personnel with sufficient time for appropriate handwashing.
- Sufficient space is available for a 1-2 meter aisle area between newborn stations.
- There is an adequate number of sinks for hand hygiene.

- Continuing instruction is given to staff about the mode of transmission of infections and specific infection control measures.

Isolation needs should be determined by the mode of transmission and by the pathogen involved, by the number of infected or colonized newborns, and by the care required.

### Single Room Isolation

- Single room isolation is recommended for infants with infections with airborne transmission, such as varicella, measles, tuberculosis and possible influenza.
- Infants of mothers with perinatal varicella should also be isolated in a single room.
- Forced air incubators cannot be substituted for isolation rooms because they discharge unfiltered air into the nursery.[19]

# Neonatal Care Unit Personnel

## Staffing

There should be sufficient personnel to provide appropriate care of infants so that there is adequate time for hand hygiene between patient contacts [19] An ideal situation would include:

- One nurse per six to eight infants in a normal nursery
- One nurse per two to three infants in an intermediate care nursery
- One nurse per one to two infants in a NICU[19]

## Personnel Health

### Assessment for infection

Employees should understand the risks of transmission of contagious diseases and report acute infections to their supervisors. Supervisors should report infections in personnel to the infection control team for assessment of the risk of transmission. [See Part I: “Occupational Safety and Employee Health”]

**Immunization history**

Potential employees should be evaluated for immunization history before employment. Personnel who provide direct patient care should be immune to:

| | |
|---|---|
| Rubella | Diphtheria |
| Measles | Tetanus |
| Mumps | Poliovirus |
| HBV | Pertussis |
| Influenza | Varicella |

**Tips for staff restrictions**

- Non-immune personnel with significant exposure to varicella, zoster, or measles should not work during the potentially contagious phase of the incubation period.
- Personnel with respiratory infections should not work in NICU till cured.
- Personnel with exudative hand dermatitis, staphylococcal skin lesions, or herpetic hand lesions should not perform direct patient care.
- Personnel with oral herpetic lesion should cover any external lesions and should avoid touching their mouth during patient care. Masks can help with this. Hands should be washed before patient contact or before contact with patient care equipment.
- Personnel should be made aware of the risk of unconscious practices such as hand-to-eye/nose mouth contact during patient care. Wearing gloves reduces such contact. Protective eyewear and faceshields may give added protection against self inoculation.
- Personnel should use standard precautions to minimize the risk of infection with blood-borne pathogens. Resuscitation bags, mouthpieces, and suction devices should be provided to eliminate the need for emergency procedures involving direct oral contact with blood or secretions such as amniotic fluid.[19]

# Environmental Factors and Design Issues for the Neonatal Unit

**Note:**

- Infection risk increases with overcrowding and understaffing.[21]
- Overworked staff may not be able to comply with hand hygiene requirements.
- Inadequate number and placement of sinks may also contribute to decreased hand hygiene.[19]

## Nursery Location and Layout

- The walls and surfaces should be of materials that are easily cleaned and disinfected.
- The nursery should be located in a low-traffic area with restricted access.
- Patient care areas should be separated from heavily used areas such as nursing stations and storage areas.

The nursery should provide adequate space for neonates.

- Ideally, there should be a sufficient number of strategically placed sinks for handwashing.
- The NICU should have good air flow.

## Visitation Policy

- Each facility should develop and enforce a clearly defined visiting policy for nurseries and NICUs.
- Policies should be designed to allow parents to visit while minimizing the risk to infants.
- Maternal visitors should be restricted while infants are with their mothers.
- Normal newborns should be visited in the mother's private room or in a special visiting area.
- The number of visitors at a time and the duration of visits should be limited.
- Visiting in special-care nurseries should be restricted to prevent interruption of patient care activities.
- It may be prudent to restrict visiting during community outbreaks of respiratory tract infections.
- Visitors should be instructed in proper handwashing technique.
- Visitors should not have contact with newborns other than the one being visited and should not handle patient care equipment.
- Visitors should be free of transmissible infections.[19]

# Equipment

## Equipment processing

- Schedules should be established for routine cleaning for all patient care equipment. Frequency of cleaning will vary with type of equipment and with potential for contamination.
- Equipment such as incubators and ventilators should be cleaned and disinfected between patients.
- Equipment in direct contact with mucous membranes of neonates should be high-level disinfected or sterilized between patients.
- Equipment assigned to a single patient, such as resuscitation bags, respiratory masks, and other items in contact with the newborn's skin or mucous membranes should be replaced and sterilized or should receive high-level disinfection on a regular basis.
- Ventilator circuits do not need changing more frequently than every 48 hours and should be cleaned and high level disinfection for each use.
- Examination equipment such as stethoscopes and ophthalmoscopes should be reserved for use with one patient or should be decontaminated with alcohol between patients.
- Reservoirs for water-borne organisms should be minimized:
    - Sterile water should be used in nebulizers and humidifiers.
    - Humidifier reservoirs in incubators should not be used if central humidification provides sufficient humidification. If used, they should be drained, cleaned, dried and filled with sterile water every 24 hours.
    - Condensate in ventilator tubings should be drained and discarded periodically.
- Sterilized linens are not routinely required for newborns.

# Environmental Cleaning

## General

The nursery should be kept clean and dust free:

- Floors and other horizontal surfaces should be cleaned daily with water and detergent. Chlorine (one hundred part per million) could be used for cleaning floors and surfaces.

- Wiping should be used as a cleaning method as it minimizes dust dispersal.
- Blood spills should be removed immediately using a disinfectant . (See Part I “Environmental Cleaning”)
- Walls, curtains, and window blinds should be cleaned often in order to prevent the accumulation of dust.
- Responsibility for the cleaning of delicate equipment, such as monitoring equipment, should be clearly assigned as such items frequently are not handled by housekeeping personnel.
- During construction or renovation, neonates and equipment should be moved to a separate area to protect them from exposure to dust and debris, which may contain fungal spores.

## Incubators

- The inside and outside of the incubators should be cleaned daily.
- Incubators should be disinfected between each baby. The incubator should also be disinfected after every 7 days of hospitalization (every 5 days for babies less than 1 kilogram).
- After use all removable parts must be washed and thoroughly cleaned with detergent. Rinse and dry thoroughly using disposable paper towels. The incubator should also be cleaned and dried. Then all parts of the incubator should be disinfected using chlorine (200-500 ppm) or isopropyl acohol (70%) or hydrogen peroxide.
- Aerate the incubator before re-use.

**Fig. 7: Incubator**

| **Note!** |
| --- |
| Please refer to the manufacturer’s instructions for decontamination of incubators. |